Barcode

A **barcode** (also **bar code**) is an optical, machine-readable representation of data; the data usually describes something about the object that carries the barcode. Traditional barcodes systematically represent data by varying the widths and spacings of parallel lines, and may be referred to as linear or one-dimensional (1D). Later, two-dimensional (2D) variants were developed, using rectangles, dots, hexagons and other geometric patterns, called *matrix codes* or *2D barcodes*, although they do not use bars as such. Initially, barcodes were only scanned by special optical scanners called barcode readers. Later application software became available for devices that could read images, such as smartphones with cameras.

A UPC-A barcode symbol

The barcode was invented by Norman Joseph Woodland and Bernard Silver and patented in the US in 1952 (US Patent 2,612,994). The invention was based on Morse code that was extended to thin and thick bars. However, it took over twenty years before this invention became commercially successful. An early use of one type of barcode in an industrial context was sponsored by the Association of American Railroads in the late 1960s. Developed by General Telephone and Electronics (GTE) and called KarTrak ACI (Automatic Car Identification), this scheme involved placing colored stripes in various combinations on steel plates which were affixed to the sides of railroad rolling stock. Two plates were used per car, one on each side, with the arrangement of the colored stripes encoding information such as ownership, type of equipment, and identification number.[1] The plates were read by a trackside scanner, located for instance, at the entrance to a classification yard, while the car was moving past.[2] The project was abandoned after about ten years because the system proved unreliable after long-term use.[1]

Barcodes became commercially successful when they were used to automate supermarket checkout systems, a task for which they have become almost universal. Their use has spread to many other tasks that are generically referred to as automatic identification and data capture (AIDC). The very first scanning of the now-ubiquitous Universal Product Code (UPC) barcode was on a pack of Wrigley Company chewing gum in June 1974.[3] QR codes, a specific type of 2D barcode, have recently become very popular.[4]

Other systems have made inroads in the AIDC market, but the simplicity, universality and low cost of barcodes has limited the role of these other systems, particularly before technologies such as radio-frequency identification (RFID) became available after 2000.

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History

In 1948 Bernard Silver, a graduate student at Drexel Institute of Technology in Philadelphia, Pennsylvania, US overheard the president of the local food chain, Food Fair, asking one of the deans to research a system to automatically read product information during checkout.[5] Silver told his friend Norman Joseph Woodland about the request, and they started working on a variety of systems. Their first working system used ultraviolet ink, but the ink faded too easily and was expensive.[6][7]

Convinced that the system was workable with further development, Woodland left Drexel, moved into his father's apartment in Florida, and continued working on the system. His next inspiration came from Morse code, and he formed his first barcode from sand on the beach. "I just extended the dots and dashes downwards and made narrow lines and wide lines out of them."[6] To read them, he adapted technology from optical soundtracks in movies, using a 500-watt incandescent light bulb shining through the paper onto an RCA 935 photomultiplier tube (from a movie projector) on the far side. He later decided that the system would work better if it were printed as a circle instead of a line, allowing it to be scanned in any direction.

On 20 October 1949, Woodland and Silver filed a patent application for "Classifying Apparatus and Method", in which they described both the linear and bull's eye printing patterns, as well as the mechanical and electronic systems needed to read the code. The patent was issued on 7 October 1952 as US Patent 2,612,994. In 1951, Woodland moved to IBM and continually tried to interest IBM in developing the system. The company eventually commissioned a report on the idea, which concluded that it was both feasible and interesting, but that processing the resulting information would require equipment that was some time off in the future.

IBM offered to buy the patent, but the offer was not accepted. Philco purchased the patent in 1962 and then sold it to RCA sometime later.[6]

Collins at Sylvania

During his time as an undergraduate, David Collins worked at the Pennsylvania Railroad and became aware of the need to automatically identify railroad cars. Immediately after receiving his master's degree from MIT in 1959, he started work at GTE Sylvania and began addressing the problem. He developed a system called *KarTrak* using blue and red reflective stripes attached to the side of the cars, encoding a six-digit company identifier and a four-digit car number.[6] Light reflected off the stripes was fed into one of two photomultipliers, filtered for blue or red.

The Boston and Maine Railroad tested the KarTrak system on their gravel cars in 1961. The tests continued until 1967, when the Association of American Railroads (AAR) selected it as a standard, Automatic Car Identification, across the entire North American fleet. The installations began on 10 October 1967. However, the economic downturn and rash of bankruptcies in the industry in the early 1970s greatly slowed the rollout, and it was not until 1974 that 95% of the fleet was labeled. To add to its woes, the system was found to be easily fooled by dirt in certain applications, which greatly affected accuracy. The AAR abandoned the system in the late 1970s, and it was not until the mid-1980s that they introduced a similar system, this time based on radio tags.[8]

The railway project had failed, but a toll bridge in New Jersey requested a similar system so that it could quickly scan for cars that had purchased a monthly pass. Then the U.S. Post Office requested a system to track trucks entering and leaving their facilities. These applications required special retroreflector labels. Finally, Kal Kan asked the Sylvania team for a simpler (and cheaper) version which they could put on cases of pet food for inventory control.

Computer Identics Corporation

In 1967, with the railway system maturing, Collins went to management looking for funding for a project to develop a black-and-white version of the code for other industries. They declined, saying that the railway project was large enough, and they saw no need to branch out so quickly

Collins then quit Sylvania and formed the Computer Identics Corporation.[6] As its first innovations, Computer Identics moved from using incandescent light bulbs in its systems, replacing them with helium–neon lasers, and incorporated a mirror as well, making it capable of locating a barcode up to several feet in front of the scanner. This made the entire process much simpler and more reliable, and typically enabled these devices to deal with damaged labels, as well, by recognizing and reading the intact portions.

Computer Identics Corporation installed one of its first two scanning systems in the spring of 1969 at a General Motors (Buick) factory in Flint, Michigan.[6] The system was used to identify a dozen types of transmissions moving on an overhead conveyor from production to shipping. The other scanning system was installed at General Trading Company's distribution center in Carlstadt, New Jersey to direct shipments to the proper loading bay

Universal Product Code

In 1966, the National Association of Food Chains (NAFC) held a meeting on the idea of automated checkout systems. RCA, who had purchased the rights to the original Woodland patent, attended the meeting and initiated an internal project to develop a system based on the bullseye code. The Kroger grocery chain volunteered to test it.

In the mid-1970s, the NAFC established the Ad-Hoc Committee for U.S. Supermarkets on a Uniform Grocery-Product Code to set guidelines for barcode development. In addition, it created a symbol-selection subcommittee to help standardize the approach. In cooperation with consulting firm, McKinsey & Co., they developed a standardized 11-digit code for identifying products. The committee then sent out a contract tender to develop a barcode system to print and read the code. The request went to Singer, National Cash Register (NCR), Litton Industries, RCA, Pitney-Bowes, IBM and many others.[9] A wide variety of barcode approaches was studied, including linear codes, RCA's bullseye concentric circle code, starburst patterns and others.

In the spring of 1971, RCA demonstrated their bullseye code at another industry meeting. IBM executives at the meeting noticed the crowds at the RCA booth and immediately developed their own system. IBM marketing specialist Alec Jablonover remembered that the company still employed Woodland, and he established a new facility in North Carolina to lead development.

In July 1972, RCA began an 18-month test in a Kroger store in Cincinnati. Barcodes were printed on small pieces of adhesive paper, and attached by hand by store employees when they were adding price tags. The code proved to have a serious problem; the printers would sometimes smear ink, rendering the code unreadable in most orientations. However, a linear code, like the one being developed by Woodland at IBM, was printed in the direction of the stripes, so extra ink would simply make the code "taller" while remaining readable. So on 3 April 1973, the IBM UPC was selected as the NAFC standard. IBM had designed five versions of UPC symbology for future industry requirements: UPC A, B, C, D, and E.[10]

NCR installed a testbed system at Marsh's Supermarket in Troy, Ohio, near the factory that was producing the equipment. On 26 June 1974, Clyde Dawson pulled a 10-pack of Wrigley's Juicy Fruit gum out of his basket and it was scanned by Sharon Buchanan at 8:01 am. The pack of gum and the receipt are now on display in the Smithsonian Institution It was the first commercial appearance of the UPC.[11]

In 1971, an IBM team was assembled for an intensive planning session, threshing out, 12 to 18 hours a day, how the technology would be deployed and operate cohesively across the system, and scheduling a roll-out plan. By 1973, the team were meeting with grocery manufacturers to introduce the symbol that would need to be printed on the packaging or labels of all of their products. There were no cost savings for a grocery to use it, unless at least 70% of the grocery's products had the barcode printed on the product by the manufacturer. IBM projected that 75% would be needed in 1975. Yet, although this was achieved, there were still scanning machines in fewer than 200 grocery stores by 1977.[12]

Economic studies conducted for the grocery industry committee projected over $40 million in savings to the industry from scanning by the mid-1970s. Those numbers were not achieved in that time-frame and some predicted the demise of barcode scanning. The usefulness of the barcode required the adoption of expensive scanners by a critical mass of retailers while manufacturers simultaneously adopted barcode labels. Neither wanted to move first and results were not promising for the first couple of years, with *Business Week* proclaiming "The Supermarket Scanner That Failed" in a 1976 article.[11][13]

On the other hand, experience with barcode scanning in those stores revealed additional benefits. The detailed sales information acquired by the new systems allowed greater responsiveness to customer habits, needs and preferences. This was reflected in the fact that about 5 weeks after installing barcode scanners, sales in grocery stores typically started climbing and eventually leveled off at a 10–12% increase in sales that never dropped off. There was also a 1–2% decrease in operating cost for those stores, and this enabled them to lower prices and thereby to increase market share. It was shown in the field that the return on investment for a barcode scanner was 41.5%. By 1980, 8,000 stores per year were converting.[12]

Sims Supermarkets were the first location in Australia to use barcodes, starting in 1979.[14]

Industrial adoption

In 1981, the United States Department of Defense adopted the use of Code 39 for marking all products sold to the United States military. This system, Logistics Applications of Automated Marking and Reading Symbols (LOGMARS), is still used by DoD and is widely viewed as the catalyst for widespread adoption of barcoding in industrial uses.[15]

Use

Barcodes such as the UPC have become a ubiquitous element of modern civilization, as evidenced by their enthusiastic adoption by stores around the world; most items other than fresh produce from a grocery store now have UPC barcodes. This helps track items and also reduces instances of shoplifting involving price tag swapping, although shoplifters can now print their own barcodes.[16] In addition, retail chain membership cards (issued mostly by grocery stores and specialty "big box" retail stores such as sporting equipment, office supply, or pet stores) use barcodes to uniquely identify consumers, allowing for customized marketing and greater understanding of individual consumer shopping patterns. At the point of sale, shoppers can get product discounts or special marketing offers through the address or e-mail address provided at registration.

They are widely used in the healthcare and hospital settings, ranging from patient identification (to access patient data, including medical history, drug allergies, etc.) to creating SOAP Notes[17] with barcodes to medication management. They are also used to facilitate the separation and indexing of documents that have been imaged in batch scanning applications, track the organization of species in biology,[18] and integrate with in-motion checkweighers to identify the item being weighed in a conveyor line for data collection.

Example of barcode on a patient identification wristband

They can also be used to keep track of objects and people; they are used to keep track of rental cars, airline luggage, nuclear waste, registered mail, express mail and parcels. Barcoded tickets allow the holder to enter sports arenas, cinemas, theatres, fairgrounds, and transportation, and are used to record the arrival and departure of vehicles from rental facilities etc. This can allow proprietors to identify duplicate or fraudulent tickets more easily. Barcodes are widely used in shop floor control applications software where employees can scan work orders and track the time spent on a job.

Barcodes are also used in some kinds of non-contact 1D and 2D position sensors. A series of barcodes are used in some kinds of absolute 1D linear encoder. The barcodes are packed close enough together that the reader always has one or two barcodes in its field of view. As a kind of fiducial marker, the relative position of the barcode in the field of view of the reader gives incremental precise positioning, in some cases with sub-pixel resolution. The data decoded from the barcode gives the absolute coarse position. An "address carpet", such as Howell's binary pattern and the Anoto dot pattern, is a 2D barcode designed so that a reader, even though only a tiny portion of the complete carpet is in the field of view of the reader, can find its absolute X,Y position and rotation in the carpet.[19][20]

Barcoded parcel

2D barcodes can embed a hyperlink to a web page. A capable cellphone might be used to read the pattern and browse the linked website, which can help a shopper find the best price for an item in the vicinity. Since 2005, airlines use an IATA-standard 2D barcode on boarding passes (Bar Coded Boarding Pass (BCBP)), and since 2008 2D barcodes sent to mobile phones enable electronic boarding passes.[21]

Some applications for barcodes have fallen out of use. In the 1970s and 1980s, software source code was occasionally encoded in a barcode and printed on paper (Cauzin Softstrip and Paperbyte[22] are barcode symbologies specifically designed for this application), and the 1991 *Barcode Battler* computer game system used any standard barcode to generate combat statistics.

Artists have used barcodes in art, such as Scott Blake's Barcode Jesus, as part of the post-modernism movement.

Symbologies

The mapping between messages and barcodes is called a *symbology*. The specification of a symbology includes the encoding of the message into bars and spaces, any required start and stop markers, the size of the quiet zone required to be before and after the barcode, and the computation of a checksum.

Linear symbologies can be classified mainly by two properties:

Continuous vs. discrete

- Characters in discrete symbologies are composed of n bars and $n - 1$ spaces. There is an additional space between characters, but it does not convey information, and may have any width as long as it is not confused with the end of the code.
- Characters in continuous symbologies are composed of n bars and n spaces, and usually abut, with one character ending with a space and the next beginning with a bar, or vice versa. A special end pattern that has bars on both ends is required to end the code.

Two-width vs. many-width

- A two-width, also called a **binary bar code**, contains bars and spaces of two widths, "wide" and "narrow". The precise width of the wide bars and spaces is not critical; typically it is permitted to be anywhere between 2 and 3 times the width of the narrow equivalents.
- Some other symbologies use bars of two different heights (POSTNET), or the presence or absence of bars (CPC Binary Barcode). These are normally also considered binary bar codes.
- Bars and spaces in many-width symbologies are all multiples of a basic width called the *module*; most such codes use four widths of 1, 2, 3 and 4 modules.

Some symbologies use interleaving. The first character is encoded using black bars of varying width. The second character is then encoded by varying the width of the white spaces between these bars. Thus characters are encoded in pairs over the same section of the barcode. Interleaved 2 of 5 is an example of this.

Stacked symbologies repeat a given linear symbology vertically

The most common among the many 2D symbologies are matrix codes, which feature square or dot-shaped modules arranged on a grid pattern. 2D symbologies also come in circular and other patterns and may employ steganography, hiding modules within an image (for example, DataGlyphs).

Linear symbologies are optimized for laser scanners, which sweep a light beam across the barcode in a straight line, reading a *slice* of the barcode light-dark patterns. Scanning at an angle makes the modules appear wider, but does not change the width ratios. Stacked symbologies are also optimized for laser scanning, with the laser making multiple passes across the barcode.

In the 1990s development of charge coupled device (CCD) imagers to read barcodes was pioneered by Welch Allyn. Imaging does not require moving parts, as a laser scanner does. In 2007, linear imaging had begun to supplant laser scanning as the preferred scan engine for its performance and durability

2D symbologies cannot be read by a laser, as there is typically no sweep pattern that can encompass the entire symbol. They must be scanned by an image-based scanner employing a CCD or other digital camera sensor technology

Scanners (barcode readers)

The earliest, and still the cheapest, barcode scanners are built from a fixed light and a single photosensor that is manually "scrubbed" across the barcode.

GTIN-Barcodes on Cokebottles
The right pictures show the redlaser of barcode readers gets of the images behind the filter

Barcode scanners can be classified into three categories based on their connection to the computer. The older type is the RS-232 barcode scanner. This type requires special programming for transferring the input data to the application program.

"Keyboard interface scanners" connect to a computer using a PS/2 or AT keyboard–compatible adaptor cable (a "keyboard wedge"). The barcode's data is sent to the computer as if it had been typed on the keyboard.

Like the keyboard interface scanner, USB scanners are easy to install and do not need custom code for transferring input data to the application program. On PCs running Windows the HID interface emulates the data merging action of a hardware "keyboard wedge", and the scanner automatically behaves like an additional keyboard.

Many phones are able to decode barcodes using their built-in camera, as well. Google's mobile Android operating system uses both their own Google Goggles application or third party barcode scanners like Scan.[23] Nokia's Symbian operating system features a barcode scanner,[24] while mbarcode[25] is a QR code reader for the Maemo operating system. In Apple iOS 11, the native camera app can decode QR codes and can link to URLs, join wireless networks, or perform other operations depending on the QR Code contents.[26] Other paid and free apps are available with scanning capabilities for other symbologies or for earlier iOS versions.[27] With BlackBerry devices, the App World application can natively scan barcodes and load any recognized Web URLs on the device's Web browser. Windows Phone 7.5 is able to scan barcodes through the Bing search app. However, these devices are not designed specifically for the capturing of barcodes. As a result, they do not decode nearly as quickly or accurately as a dedicated barcode scanner or portable data terminal.

Quality control and verification

Barcode verification examines scanability and the quality of the barcode in comparison to industry standards and specifications.[28] Barcode verifiers are primarily used by businesses that print and use barcodes. Any trading partner in the supply chain can test barcode quality. It is important to verify a barcode to ensure that any reader in the supply chain can successfully interpret a barcode with a low error rate. Retailers levy large penalties for non-compliant barcodes. These chargebacks can reduce a manufacturer's revenue by 2% to 10%.[29]

A barcode verifier works the way a reader does, but instead of simply decoding a barcode, a verifier performs a series of tests. For linear barcodes these tests are:

- Edge determination
- Minimum reflectance
- Symbol contrast
- Minimum edge contrast
- Modulation
- Defects
- Decode
- Decodability

2D matrix symbols look at the parameters:

- Symbol contrast
- Modulation
- Decode
- Unused error correction
- Fixed (finder) pattern damage
- Grid non-uniformity
- Axial non-uniformity[30]

Depending on the parameter, each ANSI test is graded from 0.0 to 4.0 (F to A), or given a pass or fail mark. Each grade is determined by analyzing the scan reflectance profile (SRP), an analog graph of a single scan line across the entire symbol. The lowest of the 8 grades is the scan grade, and the overall ISO symbol grade is the average of the individual scan grades. For most applications a 2.5 (C) is the minimal acceptable symbol grade.[31]

Compared with a reader, a verifier measures a barcode's optical characteristics to international and industry standards. The measurement must be repeatable and consistent. Doing so requires constant conditions such as distance, illumination angle, sensor angle and verifier aperture. Based on the verification results, the production process can be adjusted to print higher quality barcodes that will scan down the supply chain.

Barcode verifier standards

- Barcode verifiers should comply with the ISO/IEC 15426-1 (linear) or ISO/IEC 15426-2 (2D).

This standard defines the measuring accuracy of a barcode verifier

- The current international barcode quality specification is ISO/IEC 15416 (linear) and ISO/IEC 15415 (2D). The European Standard EN 1635 has been withdrawn and replaced by ISO/IEC 15416. The original U.S. barcode quality specification was ANSI X3.182. (UPCs used in the US – ANSI/UCC5).

This standard defines the quality requirements for barcodes and matrix codes (also called optical codes).

- As of 2011 the ISO workgroup JTC1 SC31 was developing a Direct Part Marking (DPM) quality standard: ISO/IEC TR 29158.[32]

International standards are available from the International Organization for Standardization (ISO).[33]

These standards are also available from local/national standardization organizations, such as ANSI, BSI, DIN, NEN and others.

Benefits

In point-of-sale management, barcode systems can provide detailed up-to-date information on the business, accelerating decisions and with more confidence. For example:

- Fast-selling items can be identified quickly and automatically reordered.
- Slow-selling items can be identified, preventing inventory build-up.

- The effects of merchandising changes can be monitored, allowing fast-moving, more profitable items to occupy the best space.
- Historical data can be used to predict seasonal fluctuations very accurately
- Items may be repriced on the shelf to reflect both sale prices and price increases.
- This technology also enables the profiling of individual consumers, typically through a voluntary registration of discount cards. While pitched as a benefit to the consumer, this practice is considered to be potentially dangerous by privacy advocates.

Besides sales and inventory tracking, barcodes are very useful in logistics and supply chain management.

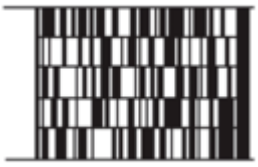
- When a manufacturer packs a box for shipment, a Unique Identifying Number (UID) can be assigned to the box.
- A database can link the UID to relevant information about the box; such as order number, items packed, quantity packed, destination, etc.
- The information can be transmitted through a communication system such as Electronic Data Interchange (EDI) so the retailer has the information about a shipment before it arrives.
- Shipments that are sent to a Distribution Center (DC) are tracked before forwarding. When the shipment reaches its final destination, the UID gets scanned, so the store knows the shipment's source, contents, and cost.

Barcode scanners are relatively low cost and extremely accurate compared to key-entry, with only about 1 substitution error in 15,000 to 36 trillion characters entered.[34] The exact error rate depends on the type of barcode.

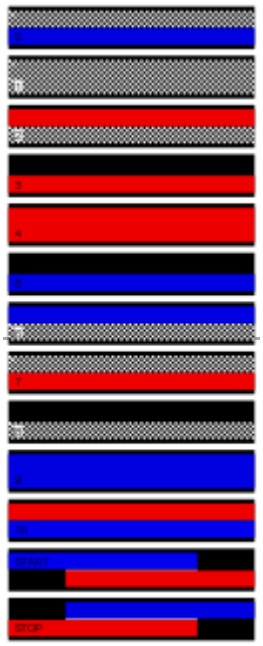
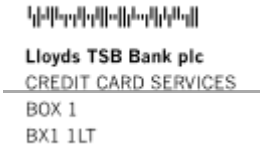
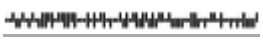
Types of barcodes

Linear barcodes

A first generation, "one dimensional" barcode that is made up of lines and spaces of various widths that create specific patterns.

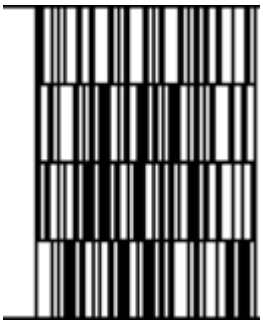
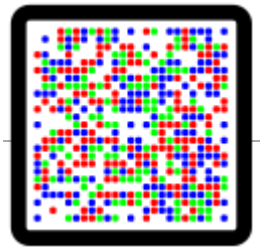
Example	Symbology	Continuous or discrete	Bar widths	Uses
	Australia Post barcode	Discrete	4 bar heights	An Australia Post barcode as used on a business reply paid envelope and applied by automated sorting machines to other mail when initially processed in fluorescent ink .
	Codabar	Discrete	Two	Old format used in libraries and blood banks and on airbills (out of date)
	Code 25 – Non-interleaved 2 of 5	Continuous	Two	Industrial
	Code 25 – Interleaved 2 of 5	Continuous	Two	Wholesale, libraries International standard ISO/IEC 16390
	Code 11	Discrete	Two	Telephones (out of date)
	Farmacode or Code 32	Discrete	Two	Italian pharmacode – useCode 39 (no international standard available)
	Code 39	Discrete	Two	Various – international standard ISO/IEC 16388
	Code 49	Continuous	Many	Various
	Code 93	Continuous	Many	Various
	Code 128	Continuous	Many	Various – International Standard ISO/IEC 15417
	CPC Binary	Discrete	Two	
	DX film edge barcode	Neither	Tall/short	Color print film
	EAN 2	Continuous	Many	Addon code (magazines),GS1-approved – not an own symbology – to be used only with an EAN/UPC according to ISO/IEC 15420
	EAN 5	Continuous	Many	Addon code (books),GS1-approved – not an own symbology – to be

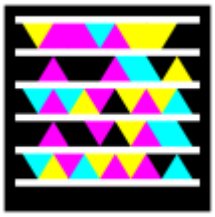
				used only with an EAN/UPC according to ISO/IEC 15420
	EAN-8, EAN-13	Continuous	Many	Worldwide retail, GS1-approved – International Standard ISO/IEC 15420
	Facing Identification Mark	Discrete	Two	USPS business reply mail
	GS1-128 (formerly named UCC/EAN-128), incorrectly referenced as EAN 128 and UCC 128	Continuous	Many	Various, GS1-approved – just an application of the Code 128 (ISO/IEC 15417) using the ANS MH10.8.2 AI Datastructures. It is not a separate symbology
	GS1 DataBar, formerly Reduced Space Symbology (RSS)	Continuous	Many	Various, GS1-approved
	Intelligent Mail barcode	Discrete	4 bar heights	United States Postal Service, replaces both POSTNET and PLANET symbols (formerly named OneCode)
	ITF-14	Continuous	Two	Non-retail packaging levels, GS1-approved – is just an Interleaved 2/5 Code (ISO/IEC 16390) with a few additional specifications, according to the GS1 General Specifications
	JAN	Continuous	Many	Used in Japan, similar and compatible with EAN-13 (ISO/IEC 15420)
	Japan Post barcode	Discrete	4 bar heights	Japan Post
	KarTrak ACI	Discrete	Coloured bars	Used in North America on railroad rolling equipment

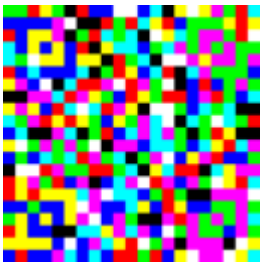
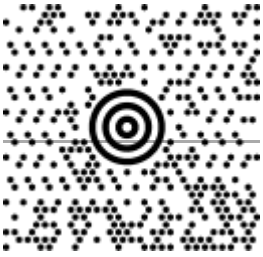
				
	MSI	Continuous	Two	Used for warehouse shelves and inventory
	Pharmacode	Discrete	Two	Pharmaceutical packaging (no international standard available)
	PLANET	Continuous	Tall/short	United States Postal Service (no international standard available)
	Plessey	Continuous	Two	Catalogs, store shelves, inventory (no international standard available)
	PostBar	Discrete	4 bar heights	Canadian Post office
	POSTNET	Discrete	Tall/short	United States Postal Service (no international standard available)
	RM4SCC / KIX	Discrete	4 bar heights	Royal Mail / PostNL
	RM Mailmark C	Discrete	4 bar heights	Royal Mail
	RM Mailmark L	Discrete	4 bar heights	Royal Mail
	Telepen	Continuous	Two	Libraries (UK)
	Universal Product Code (UPC-A and UPC-E)	Continuous	Many	Worldwide retail, GS1-approved – International Standard ISO/IEC 15420

Matrix (2D) barcodes

A *matrix code*, also termed a *2D barcode* or simply a *2D code*, is a two-dimensional way to represent information. It is similar to a linear (1-dimensional) barcode, but can represent more data per unit area.

Example	Name	Notes
	AR Code	A type of marker used for placing content inside augmented reality applications. Some AR Codes can contain QR codes inside, so that content AR content can be linked to.[35] See also ARTag.
	Aztec Code	Designed by Andrew Longacre at Welch Allyn (now Honeywell Scanning and Mobility). Public domain. – International Standard: ISO/IEC 24778
	BEEtag	A 25 bit (5x5) code matrix of black and white pixels that is unique to each tag surrounded by a white pixel border and a black pixel border The 25-bit matrix consists of a 15-bit identity code, and a 10-bit error check.[36] It is designed to be a low-cost, image-based tracking system for the study of animal behavior and locomotion.
	BeeTagg	A 2D barcode with honeycomb structures suitable for mobile tagging and was developed by the Swiss company connvision AG.[37]
	Bokode	A type of data tag which holds much more information than a barcode over the same area. They were developed by a team led by Ramesh Raskar at the MIT Media Lab. The bokode pattern is a tiled series of Data Matrix codes.[38]
	Code 1	Public domain. Code 1 is currently used in the health care industry for medicine labels and the recycling industry to encode container content for sorting.[39]
	Code 16K	The Code 16K (1988) is a multi-row bar code developed by Ted Williams at Laserlight Systems (USA) in 1992. In the USA and France, the code is used in the electronics industry to identify chips and printed circuit boards. Medical applications in the USA are well known.[40] Williams also developed Code 128, and the structure of 16K is based on Code 128. Not coincidentally, 128 squared happened to equal 16,000 or 16K for short. Code 16K resolved an inherent problem with Code 49. Code 49's structure requires a large amount of memory for encoding and decoding tables and algorithms. 16K is a stacked symbology.[41][42]
	ColorCode	ColorZip[43] developed colour barcodes that can be read by camera phones from TV screens; mainly used in Korea.[44]
	Color Construct Code	Color Construct Code is one of the few barcode symbologies designed to take advantage of multiple colors.[45][46]
	CrontoSign	CrontoSign (also called photoTAN) is a visual cryptogram[47] containing encrypted order data and a transaction authentication number.
	CyberCode	From Sony.
	d-touch	readable when printed on deformable gloves and stretched and distorted.[48][49]

	DataGlyphs	From Palo Alto Research Center (also termed Xerox PARC).[50] Patented.[51] DataGlyphs can be embedded into a half-tone image or background shading pattern in a way that is almost perceptually invisible, similar to steganography.[52][53]
	Data Matrix	From Microscan Systems, formerly RVSI Acuity CiMatrix/Siemens. Public domain. Increasingly used throughout the United States. Single segment Data Matrix is also termed Semacode. – International Standard: ISO/IEC 16022.
	Datastrip Code	From Datastrip, Inc.
	Digimarc Barcode	The Digimarc Barcode is a unique identifier, or code, based on imperceptible patterns that can be applied to marketing materials, including packaging, displays, ads in magazines, circulars, radio and television.[54]
	digital paper	patterned paper used in conjunction with a digital pen to create handwritten digital documents. The printed dot pattern uniquely identifies the position coordinates on the paper
	DotCode	Standardized as AIM Dotcode Rev 3.0. Public domain. Used to track individual cigarette and pharmaceutical packages.
	Dot Code A	Also known as *Philips Dot Code*.[55] Patented in 1988.[56]
	DWCode	Introduced by GS1 US and GS1 Germany, the DWCode is a unique, imperceptible data carrier that is repeated across the entire graphics design of a package.[57]
	EZcode	Designed for decoding by cameraphones,[58] from ScanLife.[59]
	Han Xin Barcode	Barcode designed to encode Chinese characters introduced by Association for Automatic Identification and Mobility in 2011.
	High Capacity Color Barcode	**HCCB** was developed by Microsoft; licensed by ISAN-IA.
	HueCode	From Robot Design Associates. Uses greyscale or colour.[60]

	InterCode	From Iconlab, Inc. The standard 2D barcode in South Korea. All 3 South Korean mobile carriers put the scanner program of this code into their handsets to access mobile internet, as a default embedded program.
	JAB-Code	**J**ust **A**nother **B**ar Code is a colored 2D barcode.
	MaxiCode	Used by United Parcel Service. Now public domain.
	mCode	Designed by NextCode Corporation, specifically to work with mobile phones and mobile services.[61] It is implementing an independent error detection technique preventing false decoding, it uses a variable-size error correction polynomial, which depends on the exact size of the code.[62]
	MMCC	Designed to disseminate high capacity mobile phone content via existing colour print and electronic media, without the need for network connectivity
	NexCode	NexCode is developed and patented by S5 Systems.
	Nintendo e-Reader#Dot code	Developed by Olympus Corporation to store songs, images, and mini-games for Game Boy Advance on Pokémon trading cards
	PDF417	Originated by Symbol Technologies. Public domain. – International standard: ISO/IEC 15438
	Qode	American proprietary and patented 2D barcode from NeoMedia Technologies, Inc.[59]
	QR code	Initially developed, patented and owned by Denso Wave for automotive components management; they have chosen not to exercise their patent rights. Can encode Latin and Japanese Kanji and Kana characters, music, images, URLs, emails. De facto standard for Japanese cell phones. Used with BlackBerry Messenger to pick up contacts rather than using a PIN code. The most frequently used type of code to scan with smartphones. Public Domain. – International Standard: ISO/IEC 18004

	Screencode	Developed and patented[63][64] by Hewlett-Packard Labs. A time-varying 2D pattern using to encode data via brightness fluctuations in an image, for the purpose of high bandwidth data transfer from computer displays to smartphones via smartphone camera input. Inventors Timothy Kindberg and John Collomosse, publicly disclosed at ACM HotMobile 2008.[65]
	ShotCode	Circular barcodes for camera phones. Originally from High Energy Magic Ltd in name Spotcode. Before that most likely termed TRIPCode.
	Snapcode, also called Boo-R code	used by Snapchat, Spectacles, etc.[66][67][68][69]
	Snowflake Code	A proprietary code developed by Electronic Automation Ltd. in 1981. It is possible to encode more than 100 numeric digits in a space of only 5mm x 5mm. User selectable error correction allows up to 40% of the code to be destroyed and still remain readable. The code is used in the pharmaceutical industry and has an advantage that it can be applied to products and materials in a wide variety of ways, including printed labels, ink-jet printing, laser-etching, indenting or hole punching.[70][71][72]
	SPARQCode	QR code encoding standard from MSKYNET, Inc.
	Trillcode	Designed for mobile phone scanning.[73] Developed by Lark Computer, a Romanian company.[62]
	VOICEYE	Developed and patented by VOICEYE, Inc. in South Korea, it aims to allow blind and visually impaired people to access printed information. It also claims to be the 2D barcode that has the world's largest storage capacity.

Example images

First, Second and Third Generation Barcodes

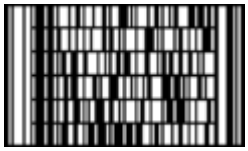
GTIN-12 number encoded in UPC-A barcode symbol. First and last digit are always placed outside the symbol to indicate Quiet Zones that are necessary for barcode scanners to work properly

EAN-13 (GTIN-13) number encoded in EAN-13 barcode symbol. First digit is always placed outside the symbol, additionally right quiet zone indicator (>) is used to indicate Quiet Zones that are necessary for barcode scanners to work properly

"Wikipedia" encoded in Code 93

"*WIKI39*" encoded in Code 39

'Wikipedia" encoded in Code 128



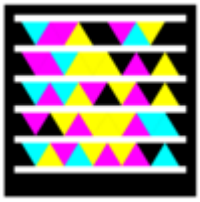
An example of a *stacked barcode*. Specifically a "Codablock" barcode.

PDF417 sample

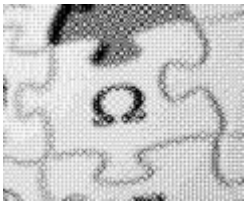
Lorem ipsum boilerplate text as four segment Data Matrix 2D

"This is an example Aztec symbol for Wikipedia" encoded in Aztec Code

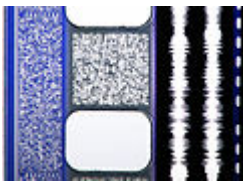
Text 'EZcode'



High Capacity Color Barcode of the URL for Wikipedia's article on High Capacity Color Barcode

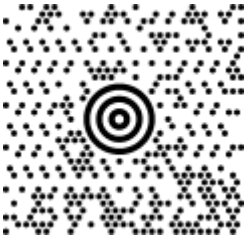


"Wikipedia, The Free Encyclopedia" in several languages encoded in DataGlyphs



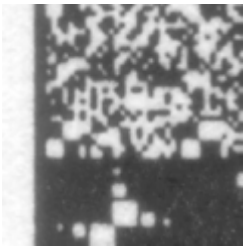
Two different 2D barcodes used in film: Dolby Digital between the sprocket holes with the "Double-D" logo in the middle, and Sony Dynamic Digital Sound in the blue area to the left of the sprocket holes

The QR Code for the Wikipedia URL. "Quick Response", the most popular 2D barcode. It is open in that the specification is disclosed and the patent is not exercised.[74]



MaxiCode example. This encodes the string "Wikipedia, The Free Encyclopedia"

ShotCode sample



detail of Twibright Optar scan from laser printed paper, carrying 32 kbit/s Ogg Vorbis digital music (48 seconds per A4 page)

A KarTrak railroad Automatic Equipment Identification label on a caboose in Florida

In popular culture

In architecture, a building in Lingang New City by German architects Gerkan, Marg and Partners incorporates a barcode design,[75] as does a shopping mall called *Shtrikh-kod* (Russian for *barcode*) in Narodnaya ulitsa ("People's Street") in the Nevskiy district of St. Petersburg, Russia.[76]

In media, in 2011, the National Film Board of Canada and ARTE France launched a web documentary entitled *Barcode.tv,* which allows users to view films about everyday objects by scanning the product's barcode with their iPhone camera.[77][78]

In professional wrestling, the WWE stable D-Generation X incorporated a barcode into their entrance video, as well as on a T-shirt.[79][80]

In the TV series Dark Angel, the protagonist and the other transgenics in the Manticore X-series have barcodes on the back of their necks.

In video games, the protagonist of the *Hitman* video game series has a barcode tattoo on the back of his head. Also, QR codes can be scanned for an extra mission on Watch Dogs.

In the films *Back to the Future Part II* and *The Handmaid's Tale*, cars in the future are depicted with barcoded licence plates.

In the Terminator films shows Skynet burns barcodes onto the inside surface of the wrists of captive humans (in a similar location to the WW2 concentration camp tattoos) as a unique identifier.

In music, Dave Davies of The Kinks released a solo album in 1980, AFL1-3603, which featured a giant barcode on the front cover in place of the musician's head. The album's name was also the barcode number.

The April, 1978 issue of Mad Magazine featured a giant barcode on the cover, with the blurb "[Mad] Hopes this issue jams up every computer in the country..for forcing us to deface our covers with this yecchy UPC symbol from now on!"

Designed barcodes

Some brands integrate still valid readable barcodes on their consumer products.

Hoaxes about barcodes

The global public launch of the barcode was greeted with minor skepticism from conspiracy theorists, who considered barcodes to be an intrusive surveillance technology, and from some Christians, pioneered by a 1982 book *The New Money System 666* by Mary Stewart Relfe, who thought the codes hid the number 666, representing the "Number of the Beast."[81] Television host Phil Donahue described barcodes as a "corporate plot against consumers".[82]

In esotericism, the red line should remove unbalance in the lines of the barcode. While the line is kept in red color, it does not disrupt scanning the barcode.

See also

- Automated identification and data capture (AIDC)
- Barcode printer
- Barcode Reading and Routing Software
- Barcode scanner
- Code (disambiguation)
- European Article Numbering-Uniform Code Council
- Global Trade Item Number
- Identifier
- Inventory control system

- ISBN
- Object hyperlinking
- Semacode
- SMS barcode
- SPARQCode
- RFID Asset Tracking Applications
- List of GS1 country codes

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Further reading

- *Automating Management Information Systems: Barcode Engineering and Implementation* – Harry E. Burke, Thomson Learning, ISBN 0-442-20712-3
- *Automating Management Information Systems: Principles of Barcode Applications* – Harry E. Burke, Thomson Learning, ISBN 0-442-20667-4
- *The Bar Code Book* – Roger C. Palmer, Helmers Publishing, ISBN 0-911261-09-5, 386 pages
- *The Bar Code Manual* – Eugene F. Brighan, Thompson Learning, ISBN 0-03-016173-8
- *Handbook of Bar Coding Systems* – Harry E. Burke, Van Nostrand Reinhold Company, ISBN 978-0-442-21430-2, 219 pages
- *Information Technology for Retail: Automatic Identification & Data Capture Systems* – Girdhar Joshi, Oxford University Press, ISBN 0-19-569796-0, 416 pages
- *Lines of Communication* – Craig K. Harmon, Helmers Publishing, ISBN 0-911261-07-9, 425 pages
- *Punched Cards to Bar Codes* – Benjamin Nelson, Helmers Publishing, ISBN 0-911261-12-5, 434 pages

- *Revolution at the Checkout Counter: The Explosion of the Bar Code* – Stephen A. Brown, Harvard University Press, ISBN 0-674-76720-9
- *Reading Between The Lines* – Craig K. Harmon and Russ Adams, Helmers Publishing, ISBN 0-911261-00-1, 297 pages
- *The Black and White Solution: Bar Code and the IBM PC* – Russ Adams and Joyce Lane, Helmers Publishing, ISBN 0-911261-01-X, 169 pages
- *Sourcebook of Automatic Identification and Data Collection* – Russ Adams, Van Nostrand Reinhold, ISBN 0-442-31850-2, 298 pages
- *Inside Out: The Wonders of Modern Technology* - Carol J. Amato, Smithmark Pub, ISBN 0831746572, 1993

External links

- Barcode at Curlie
- Barcode Glossary of Terms
- 99% Invisible - Barcodes (some images of bulls-eye barcodes)

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